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THE UNIVERSITY OF ALBERTA

RELATIONSHIPS OF FEEDLOT PERFORMANCE  
AND CARCASS CHARACTERISTICS OF SWINE.

A THESIS

SUBMITTED TO THE FACULTY OF GRADUATE STUDIES  
IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE DEGREE  
OF MASTER OF SCIENCE.

DEPARTMENT OF ANIMAL SCIENCE

BY

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## ABSTRACT

Three feeding trials were conducted with swine sired by two sires of each of three breeds. The first and second trials determined the effect of season, sex and sire upon feedlot performance and carcass characteristics of swine under restricted feeding. The second and third trials tested the effects of method of feeding, sex and sire on feedlot performance and carcass characteristics. A fourth trial, conducted with pigs from four sires, tested the effects of sex and sire on feedlot performance and carcass characteristics on a system of ad libitum feeding. The usefulness of "Lean-meter" probes for predicting carcass backfat measurements, and of a body length measurement for predicting carcass length, were studied. Apparent digestibilities of dry matter and crude protein, determined by the use of  $\text{Cr}_2\text{O}_3$  as a reference substance, were presented. The gross and error correlations among feedlot performance and carcass characteristics were calculated.

Differences in gain and efficiency of feed utilization between winter and summer seasons were likely due to lower maintenance requirements in the summer season. Differences in gain, efficiency of feed utilization, backfat thickness and loin area between restricted and liberal feeding trials were probably due to the greater excess of nutrients over maintenance requirements under liberal feeding.

Under restricted feeding females gained faster on the same amount of feed, and were leaner than males probably because they produced relatively more lean than fat tissue than did males,



selection pressure for any one. However, differences in voluntary feed consumption could not be expressed under restricted feeding.



and possibly because of lower maintenance requirements. Under liberal feeding males gained faster, were less efficient and had fatter carcasses than females because they consumed more feed and had a greater excess of nutrients over maintenance requirements.

Under restricted feeding sire groups differed in average daily gain, efficiency of feed utilization and loin area probably because of differences in the nature of their gains and in maintenance requirements. Under liberal feeding, differences in the amount of nutrients available for growth resulting from differing feed consumption, as well as differences in the nature of the gains, were probably responsible for the differences in average daily gains, efficiency of feed utilization and backfat thickness between sire groups.

"Lean-meter" probes bore a close enough relationship to carcass backfat measurements to be of use in predicting R.O.P. backfat measurements. The body length measurement showed only a fair degree of relationship to carcass length.

Apparent digestible dry matter and crude protein varied only between different levels of nutrition and were not strongly associated with any of the other characteristics studied.

Under restricted feeding, higher average daily gains were associated with lower feed requirements and thinner backfat. Under liberal feeding higher average daily gains were associated with higher feed requirements, thicker backfat and smaller loin areas. Selection pressure for any of these traits, where testing is done under restricted feeding, would have an advantage in that all desirable traits could be improved through



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## INTRODUCTION

One of the objectives of swine breeding research is the development of methods of selecting individuals that will produce carcasses desirable for food consumption and that will have also the feedlot characteristics necessary for economic production. Present standards of carcass quality emphasize the importance of a high ratio of lean to fat in the edible portion of the carcass. Rapid growth rate and efficient use of feed are feedlot characteristics of considerable importance in economic swine production.

In order to improve these traits through breeding, effective and easily measured selection criteria must be used. Visual estimates of carcass characteristics and linear body measurements, while easily obtained, have not in the past proven effective for general use in the improvement of carcass characteristics.

After suitable selection criteria have been found, it is important to know what changes might be expected in alternate traits as a result of selection pressure for any one characteristic. The present study was designed to evaluate the relationships which exist among important characteristics of swine, under restricted, liberal and ad libitum feeding regimes, in order that improved criteria for selection and more efficient testing procedures might be evolved.



## REVIEW OF LITERATURE

### A. Factors Affecting Swine Performance and Carcass Characteristics

#### 1. The Influence of Sex

The difference between males and females in performance and carcass characteristics is largely a result of their differences in relative body fatness.

Carcasses of female swine had lesser backfat thickness (A.B.T.) than did those from males (Fredeen, 1953; Hetzer et al., 1956; Fredeen and Jonsson, 1957; Berg and Bowland, 1958; Bruner et al., 1958; Bowland, 1959; Reddy et al., 1959).

Castrated males (barrows) had a higher average daily gain (A.D.G.) than did females under similar conditions (Fredeen, 1953; Berg and Bowland, 1958; Reddy et al., 1959). In a study of individually-fed Danish swine, Fredeen and Jonsson, (1957) found that females gained 1.7 per cent faster than did males, and were also more efficient in feed utilization than were males.

Many workers found that gilt carcasses had larger loin areas than did carcasses from barrows (Fredeen, 1953; Harrington and Pomeroy, 1954; Berg and Bowland, 1958; Bruner et al., 1958; Bowland, 1959) and that carcasses from gilts were longer than those from barrows (Fredeen, 1953; Berg and Bowland, 1958; Bowland, 1959).

As a result of having thinner backfat, greater loin areas and carcass length, carcasses from gilts usually received higher Record of Performance (R.O.P.) scores (Anonymous, 1959)



than did those from barrows (Fredeen, 1953; Fredeen and Lambroughton, 1956; Berg and Bowland, 1958; Bowland, 1959). As the score of the litter increased the disparity in R.O.P. score between sexes also increased (Fredeen and Lambroughton, 1956).

## 2. The Influence of Genotype

Genetic differences in efficiency of feed utilization were found in swine by Salmela et al., (1960) and in rats by Palmer et al. (1946). Additive genetic factors influencing efficiency of feed utilization accounted for 50 per cent (Dickerson, 1947), and for males and females respectively, 45 and 72 per cent (Fredeen and Jonsson, 1957) of the variation in efficiency of feed utilization.

Differences in A.D.G. were attributed to fat deposition rather than bone or muscle differences by Dickerson (1947), who found a correlation, within-sire-and-lines, of +0.6 between A.D.G. and degree of fatness. Estimates of the heritability of A.D.G., reviewed by Fredeen (1953), ranged from 0.18 to 0.58, while that of Dickerson (1947) was 0.33. In Danish swine the heritable portion of the differences in A.D.G. was 66.5 per cent for males, and 35.1 per cent for females (Fredeen and Jonsson, 1957). However, very low estimates of heritability of A.D.G. were found by Reddy et al. (1959). Breed differences (Berg, 1959) and sire-treatment interactions in A.D.G. of swine have been reported (Kristjansson, 1957; Salmela et al., 1960).

DePape and Whatley (1956) found that crossbreeds were



intermediate in A.B.T. between parent breeds, suggesting that the genes influencing backfat deposition acted largely in an additive manner. Heritability of backfat was estimated at .12 to .80 (reviewed by Fredeen, 1953). Other evidence of the genetic influence on A.B.T. determination were the sire effects and sire-treatment interactions found in swine populations. (Stothart, 1938; Cole, 1957; Fredeen and Jonsson, 1957; Kristjansson, 1957; Berg and Bowland, 1958; Berg, 1959).

Dickerson (1947) suggested that rapid fat deposition and low feed requirements were influenced by the same genes.

The additive genetic component of loin area was estimated at 65.6 per cent on a within-year-and-province basis (Fredeen, 1953). Sire-treatment interactions (Kristjansson, 1957) and strain differences (Berg and Bowland, 1958) in loin area have been reported. Significant carcass length differences between breed crosses were found by Berg and Bowland (1958). The heritability of carcass length in Canadian Yorkshires was estimated at .40 (Fredeen, 1953) and .42 (Stothart, 1947).

Total R.O.F. score varied significantly between swine strains (Berg and Bowland, 1958), and was estimated to be 35 per cent heritable (Stothart, 1947).

### 3. The Influence of Method of Feeding

Experimental work in the past has shown that restriction of T.D.N. in the range of 50 - 65 per cent of full-feeding has resulted in greater efficiency of feed utilization in swine.



(Crampton, 1937; Winters et al., 1949; Tribble et al., 1956; Cole, 1957; Braude et al., 1958; Berg and Bowland, 1958; Merkel et al., 1958a; Salmela et al., 1960). This phenomenon is expected because gains made under limited feeding are thought to be composed more of lean meat, and to be of lower caloric value than are those gains made under ad libitum feeding (Winters et al., 1949; Tribble et al., 1956). However, greater feed restriction would result in lowered efficiencies when insufficient nutrients were available above maintenance requirements for body growth (Morrison, 1956).

Conversely, if more nutrients per day are fed, there is a greater supply of nutrients above body maintenance requirements available for weight gains (Tribble et al., 1956). This would explain the high positive correlation found between daily gain and average amount of nutrients per day (Crampton, 1940; Headley, 1946; Tribble et al., 1956; Berg and Bowland, 1958; Merkel et al., 1958a; Salmela et al., 1960). However, Cole (1957) found that dilution of the ration with up to 30 per cent of corn cobs did not affect A.D.G. in swine.

Limited feeding altered the ratio of fat to lean in the carcass, as fat is the store of excess energy (McMeekin, 1940). Experimental evidence for the reduction of carcass fat on limited feeding has been found by Tribble et al. (1956), Cole (1957), Berg and Bowland (1958), Merkel et al. (1958a), Bowland (1959) and Berg and Flann (1960). However, no significant increase in loin area, (a measure of carcass leanness) was established by Berg and Bowland (1958), nor by Merkel et al. (1958b).



Cole (1957) and Berg and Bowland (1958) found no significant effect of average daily feed upon carcass length, but Crampton (1937) found that self-fed pigs were shorter than hand-fed pigs and Merkel et al. (1958a) found a correlation of -0.711 between length of carcass and per cent T.D.N. in the ration.

Merkel et al. (1958a) also found a significant correlation ( $r = .819$ ) between per cent T.D.N. in the ration and dressing percentage.

#### 4. The Influence of Environment

The influence of environment on performance and quality appears to be a result of the differing maintenance requirements of pigs due to different temperatures and different amounts of exercise. It has been found that extremely hot or cold weather will increase the maintenance requirement of the animal, lowering the animal's efficiency of feed utilization (Morrison, 1956). Pigs fed during the fall and winter had lower average daily gains than those fed in spring and summer (Evvard et al., 1927; Crampton and Ashton, 1946; Reddy et al., 1959), while those fed outside gained more slowly than those fed inside or confined to dry lot (Bowland and Berg, 1959; Reddy et al., 1959; Berg and Plank, 1960).

Differences in gain between testing stations were reported by Stothart (1938), Fredeen (1953) and Fredeen and Jonsson (1957).

Dickerson (1947) estimated that environment caused 1/6 of the variations in A.D.G. of swine, while Fredeen and Jonsson



(1957) estimated within-year-station environmental differences in A.D.G. at 33 per cent for males and 65 per cent for females in Danish swine. Environment has been estimated to cause from 25 per cent (Blunn and Baker, 1947) to 52 to 62 per cent (Fredeen, 1953) of the variation in average backfat thickness. Reddy et al. (1959) and Berg and Plank (1960) found that average backfat thickness was less for outside-raised pigs.

#### 5. Other Factors Influencing Performance and Characteristics

Initial weight of the animals at the start of a feeding trial had an effect on average daily gains, as shown by their intra-litter correlation of 0.24 found by Miranda et al. (1946).

Stothart (1938) and Fredeen (1953) stated that carcass weight had a substantial effect on backfat thickness, length and loin area. Harrington and Fomeroy (1954) agreed with the effect of carcass weight on length, while Hammond and Murray (1937) found that the liveweight of the pig affected dressing percentage more than did breed or type.

#### B. Relationships Between Performance Characteristics

It has been assumed that there exists a high correlation between rate-of-gain and efficiency of feed utilization. However, this correlation may be largely spurious. Under certain conditions the correlation is low, the higher correlations being found only in groups of animals of the same weight (Knapp and Baker, 1944; Berg, 1960).



High negative correlation between average daily gain and efficiency of feed utilization has been reported. Examples are: the gross correlation of  $-0.53$  found by Edward et al. (1927), the genetic correlation of  $-0.70$  of Dickerson and Grimes (1947), the phenotypic correlation of  $-0.96$  found, in Danish swine on individual feeding, by Fredeen and Jonsson (1957), the genetic correlation of  $-0.53$  found by Reimer et al. (1958) and the correlation of  $-0.44$  between efficiency of feed utilization and rate of maturity in Yorkshire swine found by Stothart (1938).

Average daily gains had an effect on carcass characteristics in the findings of Braude et al. (1958), in which slower growing pigs were longer, leaner and had greater loin areas, while there was no suggestion of any relationship of A.D.G. to carcass length nor leanness in the work of Crampton (1940), nor to loin area in the work of Berg and Flank (1960), while Tribble et al. (1956) found a small negative correlation ( $r = -0.20$ ) between A.D.G. and loin area.

Average backfat thickness was highly correlated with other carcass characteristics in previous studies. Aunan and Winters (1949) found it to be correlated with lean content of the carcass ( $r = -0.62$ ) and with dressing percentage ( $r = 0.66$ ). Average backfat thickness was negatively related to length of side (Hammond and Murray, 1937; Fredeen, 1953; Harrington and Pomeroy, 1954; Braude et al., 1957; Fredeen and Jonsson 1957), but with little association between these traits found by Sinclair and Murray (1935). Average backfat thickness was



positively related to loin area (Stothart, 1938) and to average daily gain (Blunn and Baker, 1947; Dickerson, 1947; Tribble et al., 1956).

Loin area was found to be negatively correlated with length of carcass in Canadian Yorkshire swine by Stothart (1938) and by Fredeen (1953), where carcass weight was constant.

#### C. Backfat Measurements on Live Animals

The degree of success in the use of the "Lean-meter" (Berg and Bowland, 1956) to measure backfat thickness on live animals was reflected in the correlation coefficients found between live probes and carcass backfat measurements. These correlation coefficients ranged from 0.48 (Anonymous O.A.C. 1957) to  $r = 0.7$  to  $r = 0.8$  (Berg and Bowland, 1956; DePape and Whatley, 1956; Brunstad and Fowler, 1959). The technique has been accepted as being of sufficient accuracy for use in livestock improvement (Hetzer et al., 1956; Tribble et al., 1956; Holland and Hazel, 1958). Berg and Bowland (1956) found that the average of 3 backfat probes was also related to total R.O.P. score ( $r = -0.65$ ) and to loin area ( $r = -0.33$ ).

#### D. The Use of Chromic Oxide ( $\text{Cr}_2\text{O}_3$ ) as an Index Substance in the Determination of Digestibility.

Success in the use of chromic oxide ( $\text{Cr}_2\text{O}_3$ ) as a reference substance in digestion studies has been reported by Schurch et al. (1952), Clawson et al. (1954) and Moore (1958).

The chromic oxide technique was found to be comparable in accuracy to the total collection technique.



## OBJECTIVES

The purpose of the experiments described hereinafter was to determine:

1. The relationships of carcass characteristics to efficiency of feed utilization, and to average daily gain; and the interrelationships among carcass characteristics, under restricted feeding, under liberal feeding, and under ad libitum feeding.
2. The utility of "Lean-meter" probes and a body length measurement in the predetermination of carcass characteristics.
3. The effect of sire and feed intake upon the apparent digestibility of dry matter and protein in the swine ration.

## EXPERIMENTAL PROCEDURE

### A. The Breeding Plan

Experimental work was conducted at the University of Alberta from November, 1959 to October, 1960. To provide the experimental animals, the available sows in the University Yorkshire herd were allotted at random, within age groups and within breeding period, to six sires - two of each of the Yorkshire, Lacombe and Landrace breeds.

The first breeding provided pigs for trial 1 (Experiment 337), conducted from November, 1959 to May, 1960 wherein each



sire was represented by 1 male and 1 female from each of three litters.

The second breeding provided pigs for trial 2, (Experiment 337A), trial 3 (Experiment 337B), and trial 4 (Experiment 337C), which were conducted from May, 1960 to October, 1960. In trials 2 and 3, each sire was again represented by three litters; each represented by 1 male and 1 female chosen at random from each litter. In trial 4, only four of the six sires were represented; each sire by 1 male and 1 female chosen at random from each of two litters. The two sires not represented here lacked sufficient offspring.

A total of 124 pigs were tested, thirty-six on each of trials 1, 2 and 3, and sixteen on trial 4.

#### B. Method of Feeding

The ration used in all trials is outlined in table 1. This ration contained approximately 21 per cent crude protein, and was well fortified with vitamins and minerals so that those pigs restricted to 75 per cent of N.R.C. allowances were still receiving adequate protein and minerals in their ration. The ration has been used successfully at the University of Alberta (Berg and Bowland, 1958).

In trials 1 and 2, to study possible differences in digestion and maintenance requirements, feed consumption was equalized by a system of limited feeding based on body weight. The pigs were fed individually according to the schedule outlined in table 2. The daily feed allowance was placed before the



pigs in the morning, at which time they were allowed to eat for one hour. In the evening, the pigs were allowed to consume any remaining portion of their daily allotment.

In trial 3, pigs were individually fed to appetite three times daily.

In trial 4, pigs were fed ad libitum in groups of four.

### C. General Management

Trials 1, 2 and 3 were conducted in the new feeding barn at the University farm, while trial 4 was conducted in the feeder wing in the farrowing barn. Both barns had concrete floors, were fan-ventilated, and temperatures were thermostically controlled to approximately 60° F.

In trials 1, 2 and 3, pigs were allotted at random, within sire groups, to groups of four, while in trial 4, sire groups of four pigs were penned together. Water was provided to all lots by automatic water cups. Shavings were used for bedding.

The pigs were placed on trial as they individually reached 39 pounds in weight, or, in trial 4, as the group average reached 39 pounds.

The pigs were weighed weekly and marketed on the weigh-day on which they surpassed 190 pounds in weight. Two days after marketing, the pigs were cut and scored according to Record of Performance (Anonymous, 1959) at a local packing plant.



One pig in trial 2 and one pig in trial 3 were marketed at lighter weights because of arrested gain.

Table 1: EXPERIMENTAL RATION

<u>Ingredient</u>	<u>% in Ration</u>
Wheat	25.0
Barley	40.95
Oats	9.2
Soybean Oil Meal	16.85
Fish Meal	4.0
Alfalfa Meal	2.0
Salt (Iodized)	0.5
Limestone	0.8
Bone Meal	0.5
Aurofac - 10	0.1
Vitamin Mix <sup>*</sup>	0.05
ZnSO <sub>4</sub>	0.05
Dry A and D <sub>2</sub>	+
<u>Vitamin Mix</u>	<u>Per Lb. Mix.</u>
Riboflavin	2. g.
Ca. Pantothenate	4. g.
Niacin	9. g.
Choline Chloride	10. g.
Folic Acid	60. mg.
B <sub>12</sub>	4.5 mg.
Pyridoxine	.5 mg.



Table 2. FEEDING SCHEDULE FOR RESTRICTED FEEDING TRIALS

<u>Weight of Pig</u> lb.	<u>New N.R.C. Allowances*</u> lb.	<u>Daily Feed 75% N.R.C.*</u> lb.
40-49	2.7	2.0
50-59	3.2	2.4
60-69	3.7	2.8
70-79	4.1	3.1
80-89	4.5	3.4
90-99	4.9	3.7
100-109	5.3	4.0
110-119	5.6	4.2
120-129	5.9	4.4
130-139	6.2	4.6
140-149	6.4	4.8
150-159	6.6	4.9
160-169	6.7	5.0
170-179	6.8	5.1
180-189	6.9	5.2
190-199	7.0	5.2

\* Values shown are for Bacon Hogs and are extrapolated from figures listed in Table 1 of Nutrient Requirements of Swine, National Research Council Publication 648: 1959.



D. Lean Meter Probes

The "Lean-meter" (See Berg and Bowland, 1956) consists of a power source (4 dry-cell batteries), an ammeter, a depth gauge and appropriate electrodes, suitably enclosed in a convenient case (Figure 5).

At the time of marketing, all pigs were probed by inserting the electrodes through the backfat at right angles to the surface of the body at 4 points, about 2 inches off the mid-line.

To determine the location of the probes, a mark was placed on the pig's shoulder directly above the center of the front leg. Another mark was placed 6 inches from the dorsal base of the tail. The distance between these two marks was measured and divided into 3 equal lengths. The four sites thus defined were designated from front to back: shoulder, back, loin and ham probes (Figure 4). The sites of the live probes were re-established after slaughter with the aid of a tape measure, and the backfat thickness at these points was recorded for comparison with the live probes.

The distance between the shoulder probe and ham probe, while recorded primarily for the re-establishment of the live probe sites, was designated "body length" and was compared to the R.O.P. carcass length to determine if this measurement had any predictive merit.



E. Determination of Apparent Digestibility of Dry Matter and Protein, Using  $\text{Cr}_2\text{O}_3$  as a Reference Substance

In trials 2 and 3 described above, the digestibilities of dry matter and nitrogen were determined using chromic oxide as a reference substance.

The technique was adapted from the procedures outlined by Schurch et al. (1952) and Clawson et al. (1945).

Each pig was placed on trial for 7 days following the weigh-day on which it surpassed 109 lbs. liveweight. The regular ration, to which was added 0.8 per cent of chromic oxide ( $\text{Cr}_2\text{O}_3$ ), was fed according to the regular schedule. On each of the last 4 days on the trial, an 150-gram sample of fresh feces was collected after both the morning and evening feeding.

The feces samples were dried in a forced-draft oven at  $88^\circ$  centigrade for 24 hours. The dried samples were then coarsely ground through a Wiley mill, and the daily samples from each pig were thoroughly mixed. From the composite sample, a smaller sample was taken, ground through a 40 - mesh sieve in a Wiley mill, and stored in a tightly-closed jar.

The feed samples were dried and ground in the same manner as the feces samples.

Total nitrogen in both the feed and feces was determined by the Kjeldahl method, using mercury as a catalyst. Total protein was estimated as total nitrogen multiplied by 6.25.

Chromic oxide ( $\text{Cr}_2\text{O}_3$ ) concentration was determined by the method of Bolin et al. (1952), using perchloric and sulfuric



acids as oxidizing agents and molybdenum as a catalyst. A Bausch and Lomb colorimeter was used to determine chromate concentration.



## RESULTS AND DISCUSSION

### 1. Analysis of Variance

The experimental data were analysed for significance of the components of variance according to the F - test of Snedecor (1956). Trials 1 and 2 were grouped together for the first analysis, while trials 2 and 3 were combined for the second analysis. Trial 4 was analysed separately. The means of performance and carcass traits are presented in Tables 4 to 11 found on pages 29 to 36. Significance of the variations of the mean squares for the main effects and their first order interactions are indicated by two asterisks corresponding to  $P < .01$ , or one asterisk indicating  $P < .05$ .

A schematic representation of the experimental design is presented in Figure 6, and an outline of the analysis of variance and covariance is as follows:

<u>Main Effects</u>	<u>Degrees of Freedom</u>
Total	71
Replicate	1
Sex	1
Sire	5
Order	2
<u>Interactions</u>	
Replicate x Sex	1
Replicate x Sire	5
Replicate x Order	2
Sex x Sire	5
Sex x Order	2
Sire x Order	10
Error	37



All mean squares were tested against the ERROR mean square.

The classification designated as "ORDER" indicates the order in which the pig was placed on trial within its particular replicate-sex-sire subgroup. This factor was intended to measure two effects; that due to linear time differences, and that due to litters, as littermates received the same "order" classification. The hierarchal classification "LITTER" was not available because of the impossibility of extracting this source of variance with the particular computer program used for analysis of variance.

A. The Effects of Season and Method of Feeding on Feedlot Performance and Carcass Characteristics

In the analysis of trials 1 and 2, the term "REPLICATE" could be replaced by "SEASON" as trial 1 was conducted in the winter season and trial 2 in the summer season.

In the first analysis, pigs in the winter period averaged 2.5 pounds lighter on test than did those in the summer period, trial 2.

The seasonal effects upon age on test, age to market and average daily gain in the two periods reflected slower gains made in the winter season, in accordance with results reported in the Review of Literature. Feed per pound gain was 3.28 on trial 1, compared to 3.00 on trial 2 probably as a result of higher maintenance requirements in the cooler winter environment.



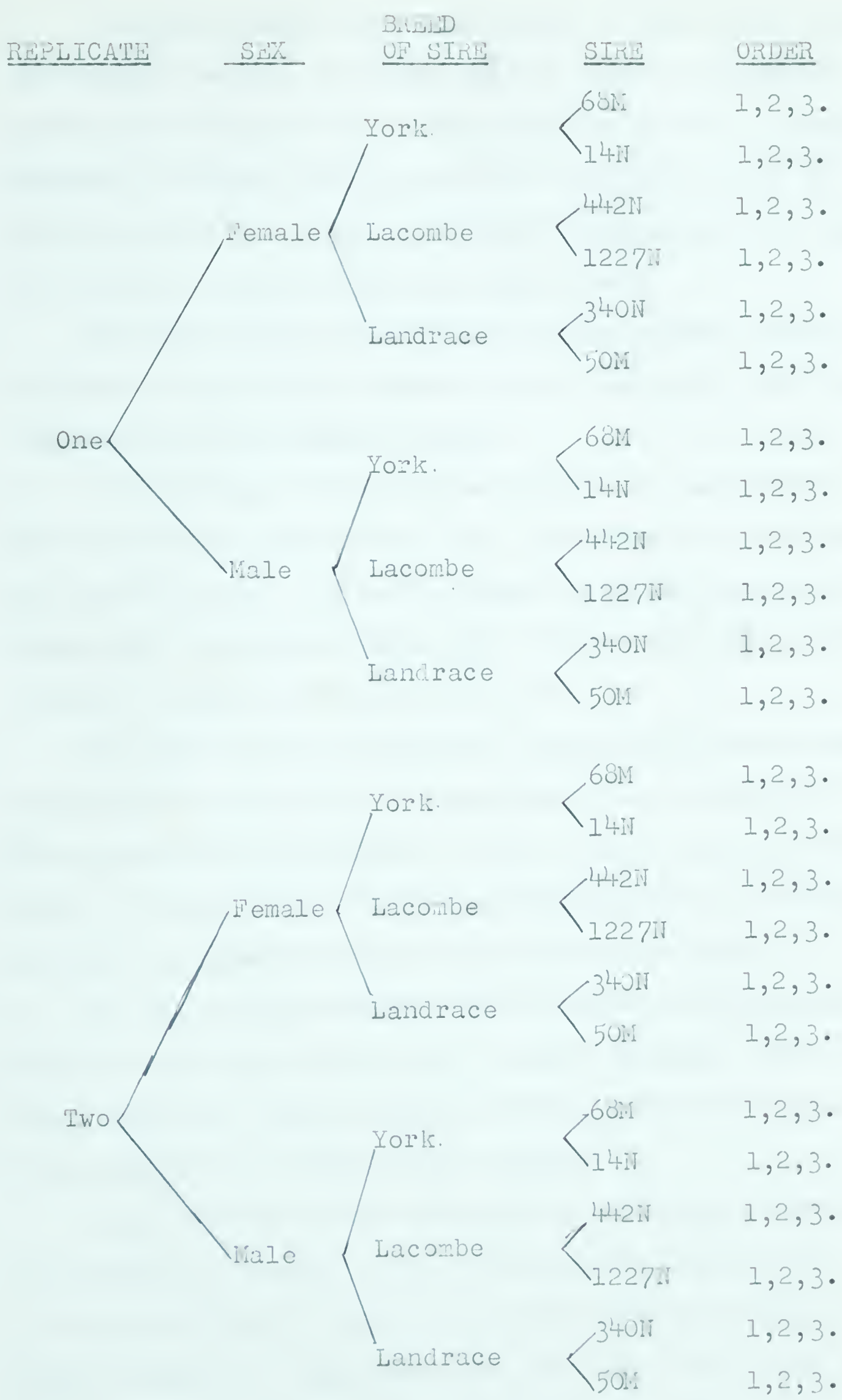


Figure 6. Experimental Design.



It was intended that average daily feed would be equal on trials 1 and 2. However, average daily feed was 3.76 pounds for trials 1 and 3.86 pounds for trial 2, probably because of higher gains in the 40 - 100 lb. period of trial 2, with the result that pigs spent relatively less time on the lower rates of average daily feed.

No explanation was obvious for the higher dressing percentage in the winter season, nor for the 0.4 inch longer carcasses in the summer season.

The fat/lean ratio is the product of the average backfat in inches multiplied by ten, and divided by loin area in square inches. It was intended to be an indicator of carcass merit and its usefulness for this purpose will be discussed later. It did not vary with season.

In Table 6, the individual "Lean-meter" probes and their corresponding carcass fat measurements are presented in detail. No explanation was obvious for the higher shoulder probe in trial 1, where neither average backfat probes or average carcass measurements showed any seasonal effect.

In the second analysis, the replicates represented: Limited feeding, trial 2; and liberal feeding, trial 3. In this analysis, initial weight, final weight and age on test were essentially equal in the trials.

Age to market and average daily gains were affected by the method of feeding. Age to market was 204 days in trial 1, 180 days in trial 2, dropping to 162 days in trial 3, and 154 days in trial 4. Average daily gain was 1.15 pounds in trial 1,



1.29 pounds in trial 2, rising to 1.43 pounds in trial 3, and 1.67 pounds in trial 4. Feed per pound gain in trial 2 was 3.00 compared to 3.11 in trial 3, exhibiting the economies of gain resulting from restriction of feed intake as offsetting the greater maintenance requirements of pigs on trial 2 because of slower gains. By comparison, the average daily feed in trial 4 (self-fed) was 6.00 pounds per day, and the feed utilization was 3.63 pounds of feed per pound of gain.

Dressing percentage rose from 74.5 to 76.3 to 78.7 per cent on trials 2, 3 and 4, respectively, thus affecting carcass weights. These results agreed with those of Merkel et al. (1958a) who found that the amount of daily nutrients directly affected the dressing percentage.

Average R.O.P. backfat thickness rose from 1.36 inches to 1.60 inches to 1.79 inches in trials 2, 3 and 4. Loin area showed the opposite trend, dropping from 3.77 square inches in trial 2 to 3.55 square inches in trial 3, and 3.42 square inches in trial 4. The higher backfat measurements on liberal feeding, aided by decreased loin area measurements, increased the fat/lean ratio. "Lean-meter" probes and carcass backfat measurements followed the same trends as R.O.P. backfat measurements. Total R.O.P. score dropped from 83.4 in trial 2 to 66.0 in trial 3 to 49.0 in trial 4, reflecting increasing fatness and decreasing leanness. These findings agreed with previous experimental results reported in the literature in that the level of nutrition affected the amount of fat in the carcass, but differed in that loin area



was affected by level of nutrition, while other workers failed to notice significant differences. Carcass length was not significantly affected by the different level of nutrition between trials 2 and 3 in this study.

The digestion studies (Table 9) showed that 77.9 per cent of dry matter was digested in trial 2, and 76.8 per cent of dry matter was digested in trial 3, while 64.1 and 61.1 per cent of crude protein was digested in trials 2 and 3, respectively. The lower digestibilities of these two nutrients under liberal feeding, were in agreement with the findings summarized by Morrison (1956).

#### B. The Effects of Sex on Feedlot Performance and Carcass Characteristics

In the first analysis, females went to market at 150 days of age, 4 days younger than did males. Females gained 1.25 pounds per day, compared to 1.20 pounds per day for males, and consumed 3.07 pounds of feed per pound of gain, while males consumed 3.21 pounds of feed per pound of gain. In the second analysis of feedlot traits, only average daily feed for the total period was significantly different for sexes, being 4.23 pounds for females and 4.34 pounds for males. This suggested a sex x season interaction in the first analysis, but no such interaction was indicated in the analysis of variance.

In the second analysis, a sex x method of feeding interaction existed for age to market, average daily gains and



average daily feed in both periods. An inspection of the data revealed the following:

	<u>Average daily gain, total period</u>	
	<u>Females</u>	<u>Males</u>
Trial 2	1.32	1.26
Trial 3	1.49	1.55

These results indicated that, on equalized feed intake, females made more efficient use of their feed for gain, and on liberal feeding, males made faster gains by eating more feed per day.

The higher gains of females in trials 1 and 2 agreed with the results of Fredeen and Jonsson (1957), but differed from those of other workers reported in the Review of Literature, wherein the method of feeding was non-restrictive.

Females had greater length, thinner backfat, greater loin area and higher total score than did males in both analyses. These results agreed with the results of other workers, notably Fredeen (1953) and Fredeen and Lambroughton (1956).

The exact nature of the differences in traits between males and females was not revealed in this study. It is possible that metabolic differences between sexes had a bearing on whether fat or lean tissue was produced. The data for the digestibility of dry matter and crude protein suggested that in this experiment the differences lay, not in digestibility differences between sexes, but rather in the use that was made of the digested nutrients.



C. The Effects of Sire on Feedlot Performance and Carcass Characteristics

In the first analysis pigs by different sires showed significant differences only in age on test and average daily gain and feed per pound gain in the total period. These data are presented in Table 4. Offspring of boars of any particular breed showed no clear superiority in any particular trait. However, this experiment was not intended to uncover any breed differences. As feed intake was equalized in trials 1 and 2, the sire differences in average daily gain and feed per pound gain were probably due to genetic differences in the way in which nutrients were used by the pigs' bodies.

In the second analysis, however, the amount of feed consumed, that is, the pigs' appetites, had an influence on feedlot performance. In this analysis, pigs from different sires showed differences in age on test, age to market, and average daily gain, average daily feed, and feed per pound gain in both periods. Again, no breed showed marked superiority in any particular characteristics.

Fairly large differences in average daily gains between sire groups on the self-feeding regime (trial 4) did not reach statistical significance. Lot averages for average daily feed and feed per pound gain were, respectively: 1227N, 6.23 and 3.65; 442N, 5.73 and 3.60; 68M, 5.21 and 3.23; and 50M, 6.65 and 4.05. These differences could not be tested statistically because of group feeding.



It was shown in this study that males and females reacted differently to restriction of feed intake. Analysis of variance for trials 2 and 3 showed that average daily feed was significantly different between the sire groups on different replicates, probably because of equalized feeding in trial 2. The replicate by sire means for certain feedlot and carcass traits are presented in Table 3.

Table 3: SELECTED REPLICATE x SIRE MEANS

Sire	A. D. Gain, lb.		A. D. Feed, lb.	Feed/lb. Gain	
	Trial 2	Trial 3		Trial 2	Trial 3
68M	1.31	1.45	4.50	2.92	3.12
14N	1.27	1.63	4.84	3.10	2.98
442N	1.29	1.48	4.78	3.03	3.23
1227N	1.24	1.49	4.71	3.10	3.16
340N	1.42	1.55	4.51	2.73	2.92
50M	1.22	1.54	4.95	3.14	3.23

	A. Backfat, in.		Loin Area, sq. in.	
	Trial 2	Trial 3	Trial 2	Trial 3
68M	1.35	1.50	3.76	3.36
14N	1.32	1.64	3.68	3.55
442N	1.40	1.59	3.89	3.68
1227N	1.38	1.53	3.69	3.35
340N	1.30	1.54	3.75	3.72
50M	1.41	1.78	3.82	3.40



The average daily feed for trial 2 was 3.06 pounds per day. It can be seen from table 3, by comparing the performance of sire groups in trial 2 with their performance in trial 3, that the pigs from 340N were fast-growing, lean and the most efficient under both feeding regimes, while those from 50M, for example, were fairly slow-growing and inefficient under restricted feeding, but were faster-growing, and very fat under non-restricted feeding because of their high daily feed intake.

D. The Effect of "Order"

This variable showed an effect only upon age on test in the second analysis. This was likely a litter effect, caused by one litter sired by sire 14N.

E. General Observations

Figures 1, 2 and 3 illustrate graphically the average performance of the pigs on the four trials, from 40 to 190 pounds liveweight. Those data from trial 4 (337C) were less informative because performance was reckoned on lot averages, rather than on individual data. In a lot of four pigs of varying size, the average daily feed would be higher on the lot basis than on an individual basis, because the smaller pigs would consume proportionately more feed for their weight than would the larger pigs, as was shown by the feed consumption curves on the first three trials. Similarly, average daily gain would be higher on the lot basis than on an individual basis, because the smaller pigs would gain proportionately more



than larger pigs. The average daily feed on the lot basis would be affected by the fact that those pigs which had the highest feed consumption would gain fastest and be removed from test first. These phenomena were illustrated by the great fluctuations in the performance curves near the end of trial 4.

It was postulated that a pig may achieve greater efficiency of feed utilization by eating more feed per day, by digesting more nutrients from its feed, by converting the nutrients to lean tissue instead of the more concentrated fat tissue, or by any combination of these.

In the first analysis (trials 1 and 2), the differences in efficiency of feed utilization must have been due principally to differences in the kind of tissue produced and to differences in maintenance requirements. Feed consumption was equalized as far as possible and the digestibility determinations in the second analysis indicated that only the amount of feed influenced dry matter and crude protein digestibility. Certainly the greater efficiency of feed utilization of the second trial indicated the effect of lower maintenance requirements in the summer period.

In the second analysis possibly all three proposed methods of achieving efficiency influenced the differences in efficiency of feed utilization found between individuals. This hypothesis was further investigated in the relationship studies.



Table 4: SUMMARY OF MEANS. ANALYSIS OF TRIALS 1 AND 2.  
FEEDLOT CHARACTERISTICS.

	Initial Wt. lbs.	Final Wt. lbs.	Age on Test Days	Age to Market Days	40# - 100#			Total Period		
					Ave. Daily Gain lbs.	Ave. Daily Feed lbs.	Feed /lb. Gain	Ave. Daily Gain lbs.	Ave. Daily Feed lbs.	Feed /lb. Gain
Replicate										
Trial 1	40.9	193	71.5	204.	1.987	2.82	2.87	1.15	3.76	3.28
Trial 2	43.4	192	64.3	180.	1.18	2.82	2.40	1.29	3.86	3.00
Sex										
Female	42.1	193	68.2	190.	1.11	2.82	2.57	1.25	3.82	3.07
Male	42.1	192	67.6	194.	1.06	2.81	2.70	1.20	3.81	3.21
Sire										
York 68M	42.2	194	71.7	194.	1.08	2.77	2.59	1.25	3.76	3.02
" 14N	41.8	190	74.7	199.	1.08	2.84	2.66	1.20	3.81	3.19
Lacombe 442N	43.0	193	66.2	189.	1.08	2.85	2.65	1.23	3.84	3.16
" 1227N	42.9	193	63.7	190.	1.06	2.85	2.72	1.20	3.83	3.21
Landrace 340N	41.4	195	68.3	189.	1.14	2.81	2.51	1.29	3.82	3.00
" 50M	41.3	191	62.8	191.	1.05	2.80	2.68	1.18	3.82	3.26
Order										
First	42.2	194	69.3	193.	1.10	2.84	2.62	1.24	3.83	3.12
Second	42.2	192	68.4	193.	1.06	2.82	2.69	1.21	3.81	3.16
Third	41.9	192	66.0	190.	1.09	2.80	2.60	1.22	3.80	3.14

All interactions non-significant.

Interactions



Table 5: SUMMARY OF MEANS. ANALYSIS OF TRIALS 1 AND 2.  
CARCASS CHARACTERISTICS.

	Carcass Wt. lbs.	Dressing %	R.O.P.		Loin Area sq.in.	Belly Score	Total R.O.P. Score	Fat/Lean Ratio	Ave. Live Probe	Ave. Carcass Fat in.
			Length in.	Fat in.						
Replicate										
Trial 1	146	75.5	30.3	1.39	3.88	18.8	78.8	3.65	1.10	1.10
Trial 2	143	74.5	30.7	1.36	3.76	19.0	83.4	3.65	1.12	1.09
Sex										
Female	145	75.0	30.7	1.33	4.02	19.6	87.5	3.34	1.06	1.05
Male	144	75.1	30.2	1.42	3.63	18.2	74.8	3.95	1.16	1.14
Sire										
York 68M	146	75.1	30.9	1.35	3.79	18.7	84.2	3.60	1.12	1.08
" 14N	145	75.0	30.8	1.35	3.71	19.2	83.1	3.69	1.07	1.05
Lacombe 442M	144	74.9	29.8	1.42	3.93	19.0	76.0	3.72	1.16	1.13
" 1227N	145	75.0	30.7	1.36	3.88	18.7	83.8	3.55	1.16	1.14
Landrace 340N	147	75.4	30.2	1.32	3.99	19.2	84.8	3.36	0.99	1.05
" 50M	143	74.6	30.5	1.44	3.65	18.7	75.0	3.97	1.14	1.14
Order										
First	144	74.5	30.4	1.38	3.92	18.8	81.7	3.56	1.10	1.09
Second	145	75.4	30.4	1.39	3.75	18.9	78.8	3.75	1.14	1.16
Third	144	75.1	30.6	1.36	3.80	18.9	82.8	3.63	1.08	1.08
Interactions										
Sex x Sire										

\* other interactions non-significant.  
 \*



Table 6: SUMMARY OF MEANS. ANALYSIS OF TRIALS 1 AND 2.  
LIVE AND CARCASS MEASUREMENTS.

	"Lean-Meter" Probes						Carcass Fat			Live Wt.	
	Shldr. Back		Loin		Ham		Shldr.	Back	Loin	Ham	Length
	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.
Replicate	★	--	--	--	--	--	--	--	--	★★	--
Trial 1	1.36	1.03	0.94	1.05	1.05	1.46	0.86	0.96	0.96	1.12	26.6
Trial 2	1.48	1.04	0.91	1.05	1.05	1.53	0.91	0.94	0.94	0.99	26.6
Sex	★	★★	★★	★	★	★★	★	--	--	★	--
Female	1.36	0.99	0.88	1.01	1.01	1.42	0.85	0.93	0.93	1.01	26.6
Male	1.48	1.08	0.97	1.09	1.09	1.57	0.92	0.98	0.98	1.10	26.6
Sire	★	★★	★	--	--	--	--	★	★	★	★
York 68M	1.39	1.05	0.98	1.06	1.06	1.47	0.88	0.93	0.93	1.02	27.7
"	1.41	0.98	0.88	1.04	1.04	1.47	0.86	0.87	0.87	1.01	27.2
Lacombe 442N	1.51	1.08	0.95	1.09	1.09	1.58	0.88	0.97	0.97	1.09	25.9
" 1227N	1.54	1.11	0.96	1.03	1.03	1.57	0.97	0.98	0.98	1.03	26.6
Landrace 340N	1.27	0.89	0.82	0.99	0.99	1.41	0.88	0.92	0.92	0.98	25.8
" 50M	1.40	1.11	0.96	1.08	1.08	1.47	0.85	1.04	1.04	1.20	26.3
Order	--	--	--	--	--	--	--	--	--	--	--
First	1.44	1.03	0.89	1.05	1.05	1.47	0.90	0.96	0.96	1.05	26.5
Second	1.46	1.04	0.95	1.09	1.09	1.54	0.88	0.95	0.95	1.09	26.7
Third	1.36	1.03	0.93	1.01	1.01	1.47	0.87	0.95	0.95	1.03	26.6
Interactions											★
Rep x Order											★
Sex x Order											★

All other interactions non-significant.



Table 7: SUMMARY OF MEANS. ANALYSIS OF TRIALS 2 AND 3.  
FEEDLOT CHARACTERISTICS.

	Initial Wt.	Final Wt.	Age on Test Days	Age to Market Days	40# - 100#			Total Period		
					Ave. Daily Gain	Ave. Daily Feed	Feed /lb. Gain	Ave. Daily Gain	Ave. Daily Feed	Feed /lb. Gain
	lbs.	lbs.	Days	Days	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.
Replicate	--	--	--	★★	★★	★★	--	★★	★★	★
Trial 2	43.4	192.	64.3	180	1.18	2.82	2.40	1.29	3.86	3.00
Trial 3	42.6	194.	62.4	162	1.43	3.55	2.49	1.52	4.71	3.11
Sex	--	--	--	--	--	--	--	--	★	--
Female	42.7	194.	62.3	171	1.31	3.15	2.40	1.41	4.23	3.02
Male	43.3	193.	63.7	171	1.30	3.22	2.48	1.41	4.34	3.09
Sire	--	--	★★	★★	★	★	★	★★	★★	★★
York 68M	41.9	192.	65.7	175	1.29	3.08	2.38	1.38	4.16	3.02
" 14N	43.1	193.	73.0	179	1.36	3.26	2.40	1.45	4.36	3.04
Lacombe 442N	43.2	194.	61.7	171	1.29	3.22	2.49	1.39	4.33	3.13
" 1227N	44.2	192.	57.5	167	1.26	3.17	2.53	1.37	4.28	3.13
Landrace 340N	42.4	195.	61.8	165	1.35	3.10	2.30	1.48	4.19	2.82
" 50M	43.2	192.	60.4	170	1.28	3.28	2.56	1.38	4.40	3.18
Order	--	--	★	--	--	--	--	--	--	--
First	44.0	194.	66.0	174	1.32	3.18	2.41	1.40	4.30	3.07
Second	42.8	192.	63.4	170	1.30	3.22	2.48	1.42	4.33	3.06
Third	42.2	192.	60.5	169	1.30	3.16	2.43	1.40	4.24	3.03
Interactions	--	--	--	★	★	★	--	★★	★	--
Rep x Sex	--	--	--	--	--	--	--	--	★	--
Rep x Sire	--	--	--	--	--	--	--	★	★	--
Sire x Order	--	--	★★	★	--	--	--	★	★	--

All other interactions non-significant.



Table 8: SUMMARY OF MEANS. ANALYSIS OF TRIALS 2 AND 3.  
CARCASS CHARACTERISTICS.

	Dress-		Ave.		Loin Area	Belly Score	Total R.O.P. Score	Fat/Lean Ratio	Ave.	
	Carcass Wt. lbs.	ing %	R.O.P. Length in.	Fat in.					Live. Probe in.	Carcass Fat in.
Replicate										
Trial 2	143	74.5	30.7	1.36	3.77	19.0	83.4	3.65	1.12	1.09
Trial 3	148	76.3	30.8	1.60	3.55	15.6	66.0	4.55	1.40	1.27
Sex										
Female	146	75.5	30.9	1.44	3.85	18.2	80.1	3.78	1.23	1.14
Male	145	75.3	30.6	1.52	3.47	16.4	69.3	4.42	1.28	1.21
Sire										
York 58M	145	75.5	30.9	1.42	3.69	19.0	81.3	3.88	1.26	1.13
" 14N	146	75.4	31.2	1.48	3.62	18.3	76.0	4.14	1.21	1.15
Lacombe 442N	146	75.5	30.6	1.50	3.78	16.7	75.2	4.03	1.27	1.18
" 1227N	145	75.3	30.8	1.45	3.52	16.3	73.9	4.18	1.29	1.22
Landrace 340N	146	75.0	30.6	1.42	3.73	18.3	78.4	3.88	1.19	1.13
" 50M	145	75.9	30.6	1.59	3.61	15.2	63.5	4.48	1.33	1.26
Order										
First	146	75.3	30.7	1.49	3.73	17.5	75.9	4.04	1.25	1.18
Second	145	75.6	30.7	1.51	3.64	17.2	72.2	4.22	1.31	1.20
Third	145	75.4	30.9	1.44	3.61	17.2	76.0	4.04	1.22	1.16
Interactions										
Rep x Sex	*		*			*	*			*
Rep x Sire	*		*			*	*			*
Sex x Sire				*				*		*
Sire x Order	*		*							

All other interactions non-significant.

All other interactions non-significant.



Table 9: SUMMARY OF MEANS. ANALYSIS OF TRIALS 2 AND 3.  
LIVE AND CARCASS MEASUREMENTS.

	"Lean-Meter" Probes						Carcass Fat		Live Wt. Length in.	Dry Matter Digest %	Crude Protein Digest %
	Shldr. in.	Back in.	Loin in.	Ham in.	Shldr. in.	Back in.	Loin in.	Ham in.			
Replicate	★	★	★	★	★	★	★	★	--	★	★
Trial 2	1.48	1.04	0.91	1.05	1.53	0.91	0.94	0.99	26.6	77.9	84.1
Trial 3	1.80	1.37	1.14	1.27	1.72	1.06	1.08	1.21	26.6	76.8	81.1
Sex	--	--	--	--	★	★	--	--	--	--	--
Female	1.61	1.17	1.00	1.14	1.58	0.94	0.99	1.03	26.7	77.8	82.7
Male	1.67	1.24	1.05	1.18	1.67	1.03	1.03	1.13	26.5	76.9	82.5
Sire	--	--	★	--	--	★	★	★	★	--	--
York 68M	1.67	1.18	1.05	1.16	1.60	0.93	0.96	1.04	27.4	77.8	82.9
" 14N	1.59	1.18	0.94	1.12	1.63	0.97	0.95	1.07	27.2	77.9	83.6
Lacombe 442N	1.68	1.20	1.02	1.17	1.65	0.94	0.99	1.13	26.0	77.0	82.3
" 1227N	1.72	1.23	1.07	1.15	1.67	1.08	1.06	1.08	26.8	76.7	82.0
Landrace 340N	1.55	1.12	0.96	1.11	1.55	0.98	0.99	1.03	25.8	77.3	82.5
50M	1.64	1.32	1.11	1.25	1.64	1.02	1.11	1.27	26.3	77.2	82.4
Order	★	--	--	--	--	--	--	--	--	--	★
First	1.63	1.21	1.00	1.14	1.62	0.98	1.02	1.11	26.8	77.3	83.1
Second	1.72	1.25	1.07	1.20	1.67	1.00	1.01	1.12	26.4	78.0	83.0
Third	1.57	1.16	1.00	1.13	1.58	0.98	1.00	1.08	26.6	76.6	81.7

Interactions  
Rep x Sire  
Sex x Sire  
Sire x Order

★ ★ ★  
★ ★  
All other interactions non-significant.



Table 10: SUMMARY OF MEANS. ANALYSIS OF TRIAL 4.

	Initial Weight		Age on Test	Age to Mrkt.	Total Period Ave.	Dressing Percent	Carcass Weight	R.O.P. Length	R.O.P. Fat	Loin Area
	lbs.	lbs.	Days	Days	Daily Gain		lbs.	in.	in.	sq.in.
Sex	--	--	--	--	--	--	--	--	--	--
Female	46.5	195.	62.5	152	1.69	153.	78.5	31.3	1.74	3.46
Male	43.9	196.	62.5	155	1.65	155.	78.9	30.9	1.84	3.38
Sire	★	--	★★	--	--	★	--	--	--	--
Lacombe: 1227N	48.5	198.	60.0	146	1.75	156.	78.8	31.1	1.86	3.25
" 442N	46.2	191.	62.0	152	1.62	149.	78.0	30.8	1.74	3.44
York: 68M	42.2	195.	61.0	154	1.67	153.	78.7	30.8	1.78	3.55
Landrace: 50M	43.7	199.	67.0	162	1.66	158.	79.3	31.7	1.79	3.44
Order	--	--	★★	--	--	--	--	--	--	--
First	47.2	196.	64.5	156	1.66	154.	78.7	31.0	1.82	3.32
Second	43.1	195.	60.5	152	1.68	154.	78.7	31.2	1.76	3.52

Interactions  
Sire x Order

★★

All other interactions non-significant.



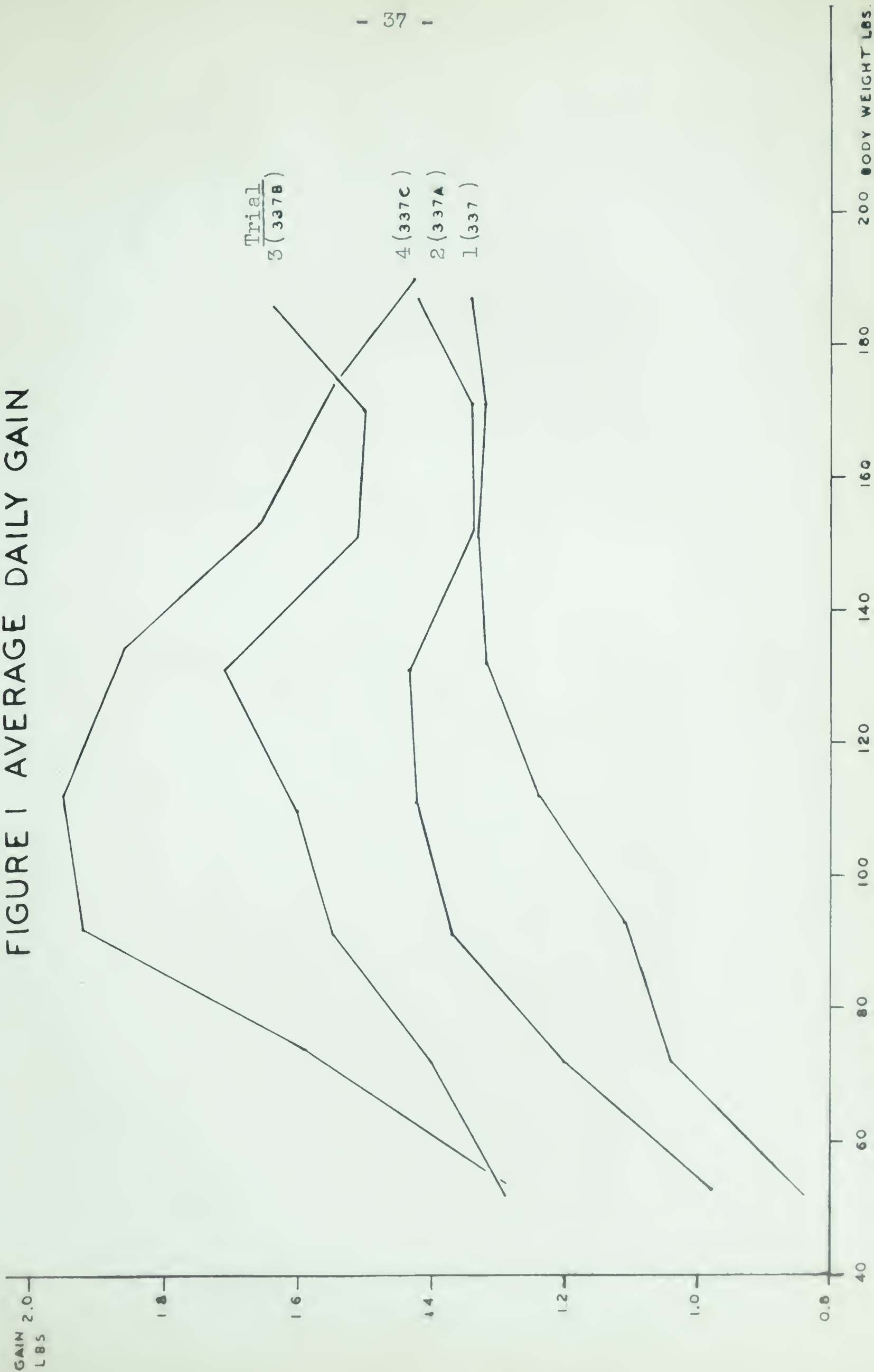
Table 11: SUMMARY OF MEANS. ANALYSIS OF TRIAL 4.

	Belly Score	Total R.O.P. Score	Fat/ Lean Ratio	Ave. Live Probe in.	Ave. Carcass Fat in.	Live Wt. Length
Sex	--	--	--	--	--	--
Female	11.2	52.7	5.12	1.58	1.40	26.9
Male	9.5	45.3	5.48	1.56	1.45	27.4
Sire	*	--	--	--	--	*
Lacombe 1227N	7.0	41.0	5.14	1.78	1.55	27.0
" 442N	15.0	54.8	5.10	1.59	1.36	25.5
York 68M	12.5	53.0	5.13	1.38	1.37	27.2
Landrace 50M	7.0	47.5	5.23	1.54	1.40	28.8
Order	--	--	--	--	--	--
First	8.5	44.4	5.56	1.57	1.44	27.1
Second	12.2	53.8	5.04	1.58	1.40	27.1

Interactions All interactions non-significant.



FIGURE 1 AVERAGE DAILY GAIN





# FIGURE 2 AVERAGE DAILY FEED

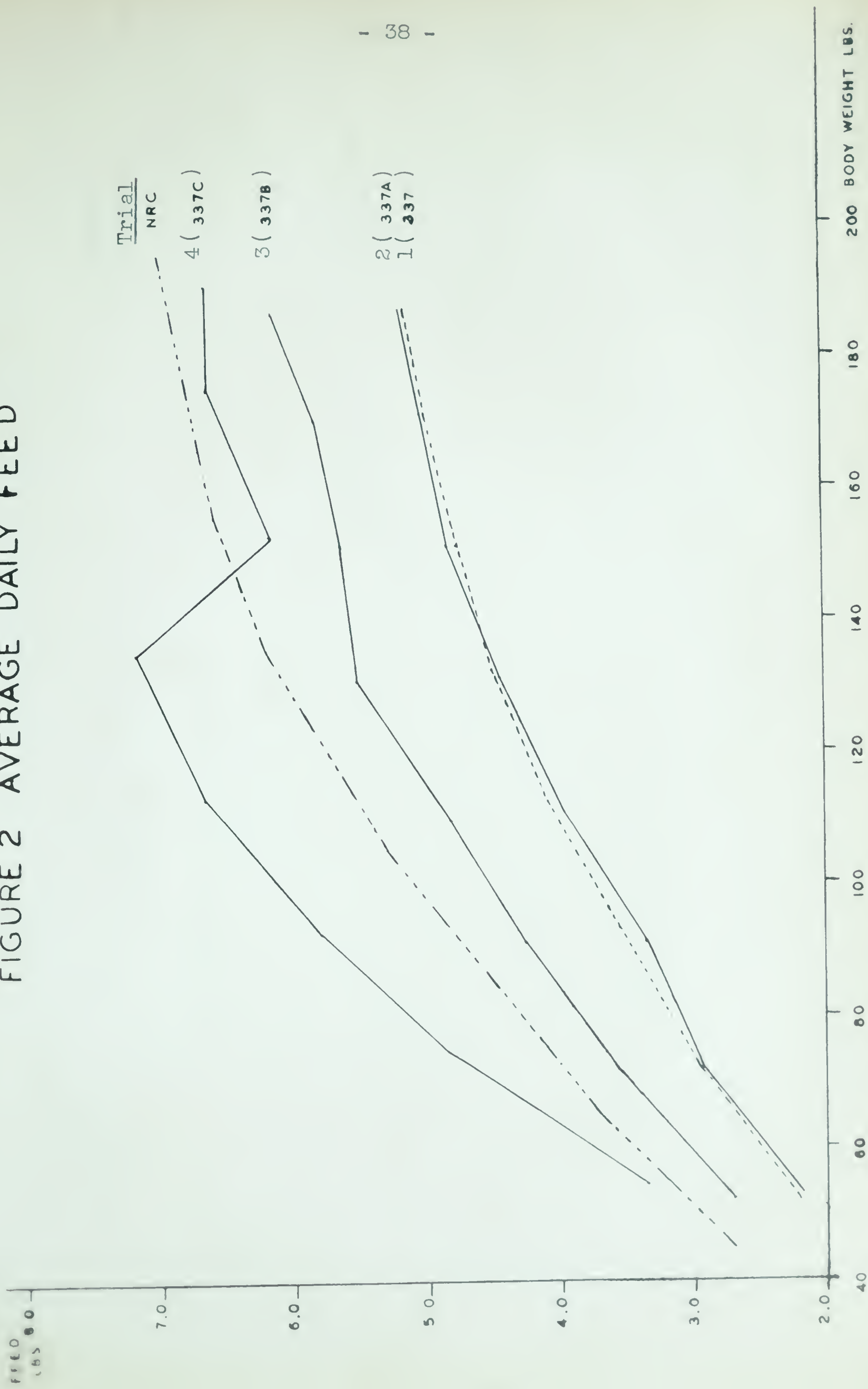
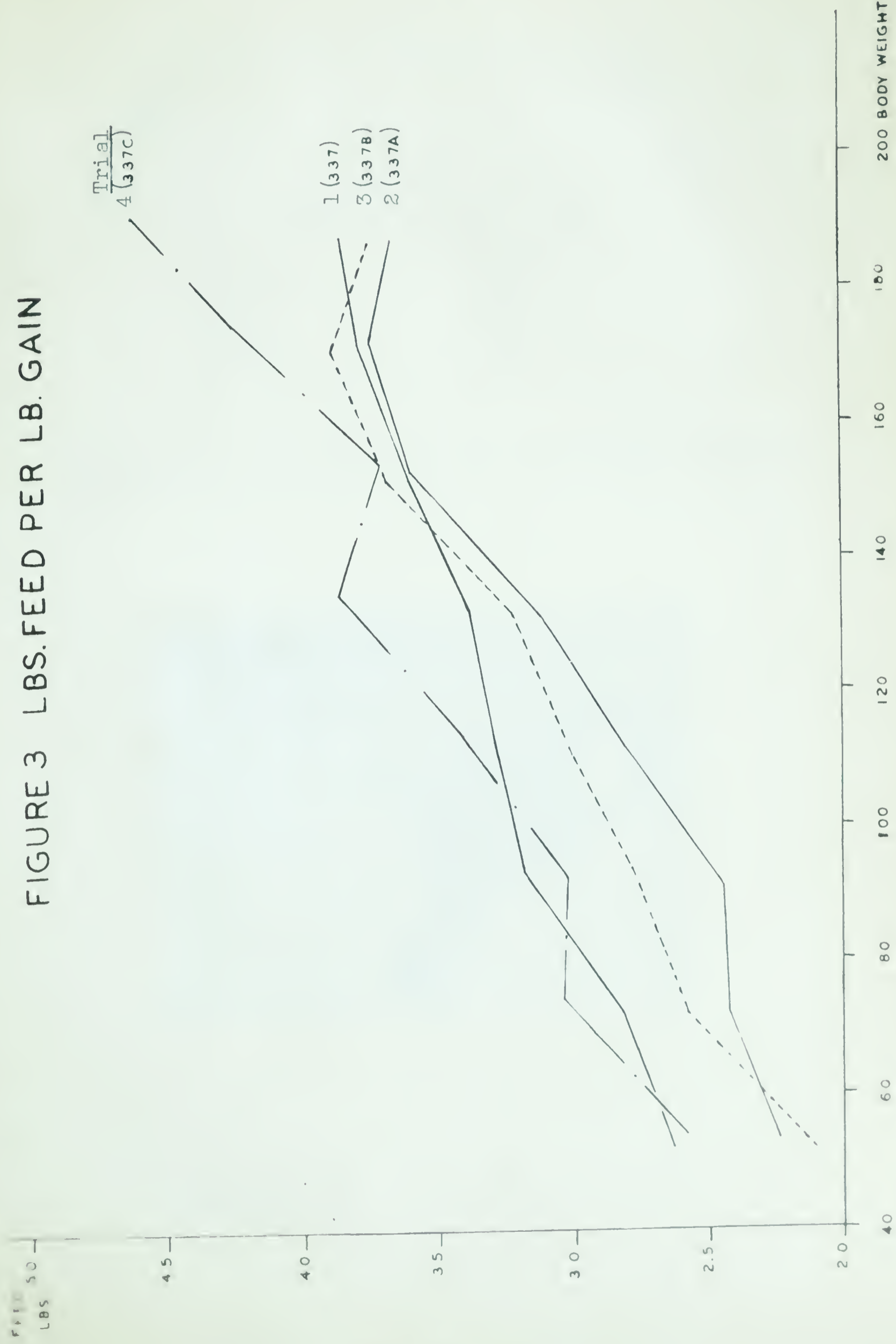




FIGURE 3 LBS. FEED PER LB. GAIN





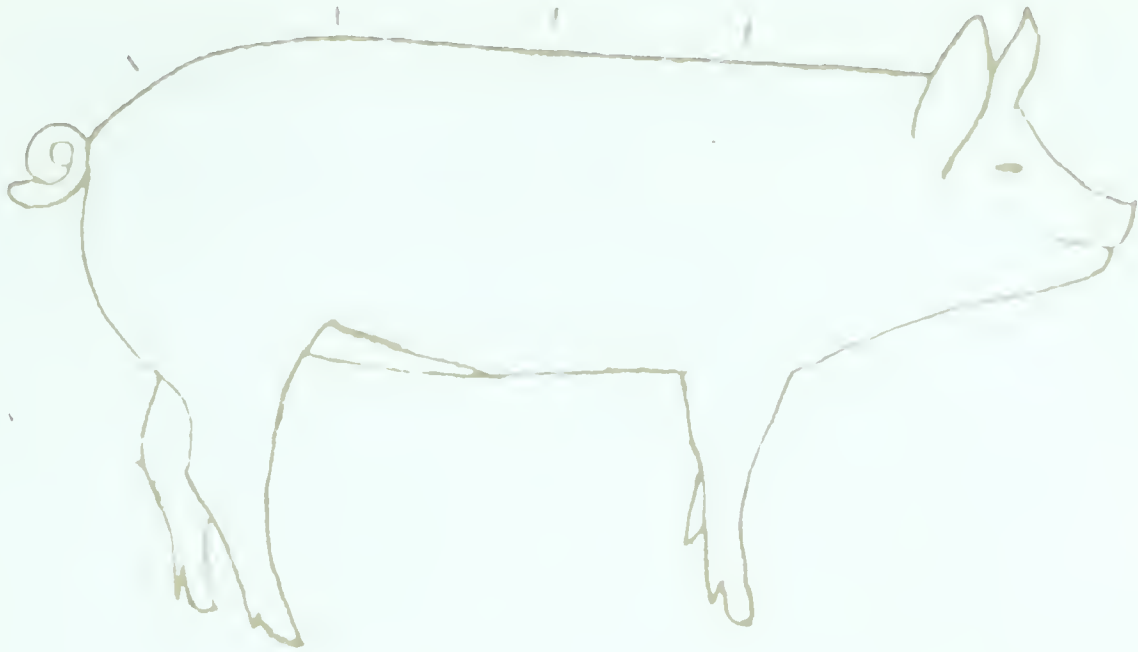


FIGURE 4 SITES OF LIVE BACKFAT PROBES



FIGURE 5 THE LEANMETER



## 2. The Relationships Between Feedlot Performance and Carcass Characteristics

Coefficients of correlation between selected feedlot performance and carcass characteristics are presented in tables 12 to 19, in pages 56 to 63. These coefficients were calculated according to the method outlined by Snedecor (1956).

For the first and second analysis, two coefficients are presented for each pair of traits considered. The upper figure ( $r_t$ ) is the coefficient calculated from the total sums of squares and sums of cross-products, with 70 degrees of freedom.

The lower figure ( $r_e$ ) is the coefficient calculated from the error terms with 36 degrees of freedom for the correlation coefficient.

For the fourth trial, only the coefficients calculated from the total sums of squares and sums of cross-products are presented, with 14 degrees of freedom, in tables 18 and 19.

The statistical significance of these coefficients at the  $P < .05$  and  $P < .01$  level is indicated by single or double asterisks, respectively.

### A. Relationships Among Feedlot Performance Traits

The relationships between age on test and age to market ( $r_t = .72$ ,  $r_e = .72$  for the first analysis,  $r_t = .57$ ,  $r_e = .72$  for the second analysis) were not unexpected, as age on test is a part of age to market (Snedecor 1956). The lower relationship,  $r_t = .36$ , in trial 4 was possibly a result of the variability in the time spent on test where a pig had greater opportunity to express individual growth potential. Similarly, the lower



gross correlation on the second analysis reflected the individual variability in time on test of the liberally-fed pigs in trial 3.

The high negative correlations of age to market with average daily gain, ranging from  $r = -.71$  to  $r = -.94$ , were due in part to the fact that the denominator of the ratio, average daily gain, was a part of the age to market.

Average daily gain in the first period was not affected by age on test, but performance in the first period was affected by initial weight (Table 14). The high positive correlations of average daily gains in the two periods were expected as the first period was a portion of the total period.

The relationships between average daily gain and feed per pound gain in the first analysis were high and negative ( $r_t = -.97$  and  $r_e = -.94$  for the first period and  $r_t = -.96$  and  $r_e = -.95$  for the total period). Those on the second analysis were lower ( $r_t = -.22$  and  $r_e = -.76$  for the first period, and  $r_t = -.35$  and  $r_e = -.80$  for the total period). These results were in agreement with those of other workers.

The lower correlations for the second analysis resulted from the mathematical nature of the traits correlated. Feed per pound gain can be written as A.D.F./A.D.G. When this ratio is correlated with A.D.G. it can be seen that A.D.G. is present as the denominator in "Feed/lb. gain" causing a spurious correlation. Under controlled feeding (trials 1 and 2) A.D.F. was held fairly constant between pigs, resulting in the very high negative correlations of feed/lb. gain with average



daily gains in the first analysis. Under the less restrictive feeding of trial 3, A.D.F. varied more because of appetite differences among pigs and a lower correlation resulted. These relationships were further clarified by statistically controlling A.D.F. in the calculation of the partial correlation coefficient for the second analysis,  $r_{12.3}$ , where 1 = A.D.G., 2 = Feed/lb. gain and 3 = A.D.F., (total period) by the formula  $r_{12.3} = \frac{r_{12} - r_{13} r_{23}}{\sqrt{(1-r_{13}^2)(1-r_{23}^2)}}$  of Snedecor (1956) using the gross correlation coefficients for the traits involved. This partial correlation was high and negative ( $r_{12.3} = -.99$ ) as expected.

A similar effect was noted in the relationship of average daily feed with average daily gain, whereby a low relationship ( $r_t = .36$ ) was found in the first analysis under controlled feeding and a high relationship ( $r_t = .76$ ) was found in the second analysis where feed intake was more variable. The non-significant error correlations,  $r_e = -.06$  and  $r_e = .14$ , indicated that when the effects of wide fluctuations in feed intake associated with replicate, genotype and sex were removed there was little association between gain and feed intake.

The correlations of average daily feed with feed per pound gain ( $r_e = .34$  for the first analysis, and  $r_t = .33$ ,  $r_e = .47$  for the second analysis) were of the same spurious nature discussed above. The analysis of covariance revealed that the discrepancy between  $r_t$  and  $r_e$  on the first analysis was principally due to the replicate portion of covariance of average daily feed to feed per pound gain.



B. The Relationships of Feedlot Performance to Carcass Characteristics

Merkel et al. (1958a) found that the level of nutrition was related to dressing percentage,  $r = .82$ , while Aunan and Winters (1949) found that backfat thickness was related to dressing percentage,  $r = .66$ . In the first analysis, the pigs with the thickest backfat took longest to reach market weight, and had the highest dressing percentage. Conversely, in the second analysis and on trial 4 the pigs having the thicker backfat and higher dressing percentages went to market sooner than their slower growing, leaner contemporaries. This accounted for the correlations between age to market and dressing percentage  $r_t = .37$  in the first analysis,  $r_t = -.23$  for the second analysis and  $r = -.43$  for trial 4. The non-significance of the  $r_e$  values for both analyses suggested that the gross correlations were due to replicate, genotype and sex effects.

The correlations of age to market with average backfat ( $r_t = .25$  for trials 1 and 2 and  $r_t = -.42$  for trials 2 and 3) show the same trend in that on controlled feed intake leaner, more efficient pigs reached market weight first whereas on unrestricted feeding faster gaining pigs were fatter. The positive correlation of age to market with loin area,  $r_t = .24$  on the second analysis, did not contradict this idea, but resulted from pigs on trial 2 being both leaner and older at market weight than pigs on trial 3.



The relationships of age to market and total score,  $r_t = -.26$  and  $r_t = .43$ , for analysis 1 and 2 respectively, which were much higher than the  $-.06$  reported for these traits by Fredeen (1953), arose indirectly from the relationships of age to market to backfat thickness and loin area, both of which influenced total score. In contrast, the fat/lean ratio, involving backfat thickness and loin area, was not related to age to market.

Following the pattern established for age to market above, the relationship of average daily gain to average backfat,  $r_t = -.42$  on the first analysis,  $r_t = .42$  on the second analysis, and  $r = .51$  on trial 4, was higher than the correlations of  $-.25$  for males reported by Fredeen and Jonsson (1957), and  $.29$  reported by Blunn and Baker (1947). Average daily gain was related to loin area only in the second analysis, where  $r_t = -.28$ , and to total score,  $r_t = .42$  and  $r_t = -.44$ , for analysis 1 and 2 respectively, reflecting the influence of rate of gain on carcass fatness. The relationship of average daily gain to carcass length,  $r_t = .30$ , on the first analysis, has no obvious explanation, other than the replicate effect on both characteristics, wherein length and average daily gain were both greater on trial 2, as was outlined earlier. A similar explanation might hold for the relationship of feed per pound gain and length where  $r_t = -.52$  on the first analysis.

The correlations of feed per pound gain and loin area were negative but non-significant, while those of feed per pound gain and average backfat thickness were  $r_t = .40$  for the first



analysis and  $r_t = .37$  for the second analysis indicating a trend for more efficient pigs to have less backfat. Similarly feed per pound gain was related to total score,  $r_t = -.42$  and  $r_t = -.37$  for analysis 1 and 2 respectively. In trials 2 and 3 (Table 15), average daily feed was related to average backfat thickness,  $r_t = .67$ ; to loin area,  $r_t = -.41$ ; and to total score,  $r_t = -.69$  and  $r_e = -.34$ , indicating that excess feed consumed was converted to fat, which lowered carcass quality.

It was noted that in many of the relationships above that gross correlation ( $r_t$ ) was significant, while error correlation ( $r_e$ ) was non-significant.

In the first analysis, it was noted that the replicate portion of covariance contributed a major portion of total covariance of the following pairs of traits: age to market with average backfat thickness and total score; and average daily gain with carcass length. In this trial the covariance due to sexes was also a major portion of total covariance of feedlot and carcass characteristics.

Examination of the covariance analysis for trials 2 and 3 revealed that the replicate portion of covariance was the major part of the total covariance of the following pairs of traits: age to market with loin area, average backfat and total score; average daily gain with average daily feed, average backfat thickness, loin area, total score, and the fat/lean ratio; average daily feed with average backfat thickness, loin area, total score, and the fat/lean ratio; and feed per



pound gain with average backfat thickness, total score, and the fat/lean ratio.

The major contribution of replicate covariance to the total relationships between the aforementioned traits reflected the effect of method of feeding, and to a minor extent that of season, on the relationships of feedlot characteristics to carcass characteristics.

It was of interest that the signs of certain correlations in the second analysis were reversed from those in the first analysis. The correlations showing this phenomenon were: age to market with dressing percentage, average backfat thickness, loin area and total score; average daily gain with average feed per pound gain; and feed per pound gain with average backfat thickness. It was postulated that the correlations between these traits were different in trial 3 from those in trial 1 and 2, and the correlations for trial 3 alone, were recalculated with 34 degrees of freedom for the gross correlations. These correlations are presented in table 20, with the gross correlations ( $r_t$ ) from the analysis of trials 2 and 3 combined, in parentheses. In trial 3, only the correlation of age to market with dressing percentage was reversed in sign from that of the combined analysis. The correlation of average daily gain with average backfat thickness was lower than that of average daily gain to loin area suggesting that gain was dependent upon the pig's muscular development. In this regard, the correlation of average daily gain with average backfat thickness,  $r_t = -.42$  for trials 1 and 2,  $r = .24$  for trial 3



and  $r = .51$  for trial 4, suggests that the availability of nutrients determines the nature of the gains, with gains being largely of lean tissue under restricted feeding and being composed of more fat tissue when nutrients are more plentiful.

Table 20. Summary of Correlation Coefficients for Trial 3.

		Total Period	
	Age to Market	Ave. Daily Gain	Feed /lb. Gain
<u>Total Period</u>	Ave.		.420 *
	Daily Feed		(.333 **)
	Feed Per Pound Gain	-.597 ** (-.346 **)	
Dressing Per cent	.286 (-.232) *		
<u>R.O.P.</u>			
Ave. Back Fat	-.310 (-.420 **)	.243 (.425 **)	.123 (.373 **)
Loin Area	.458 ** (.241 **)	-.408 * (-.278 *)	
Total Score	.455 ** (.429 **)	-.391 * (-.440 **)	

### C. Relationships Among Carcass Characteristics

The relationships found among certain carcass characteristics are summarized in Table 13, for the first analysis, Table 16 for the second analysis, and Tables 18 and 19 for trial 4.

The "spurious" correlations (Snedecor, 1956) of carcass weight to final weight ranged from  $r_t = .72$  on the second analysis to  $r = .82$  on trial 4, while the correlations of carcass weight to dressing percentage ranged from  $r_e = .43$  in the first



analysis to  $r_t = .59$  in the second analysis.

Carcass weight did not affect carcass length, average backfat thickness, or total score in the first analysis but was related to loin area,  $r_t = .34$  and  $r_e = .49$ , and to the fat/lean ratio,  $r_e = .35$ . In the second analysis, carcass weight was related to carcass length,  $r = .28$  and  $r_e = .32$  to average backfat thickness,  $r_t = .41$ , to loin area,  $r_e = .33$  to total score,  $r_t = -.31$  and to the fat/lean ratio,  $r_t = .25$ . The results from this analysis were comparable to those of Stothart (1938) who found that carcass weight was related to length,  $r = .39$ , to shoulder fat,  $r = .27$  and to backfat,  $r = .62$ .

Analysis of covariance revealed that the greater part of the gross covariance of carcass weight with carcass length, average backfat thickness, loin area, total score and the fat/lean ratio in the second analysis was due to the covariance of these factors between replicates. Trial 3, which had an average carcass weight of 148 pounds, versus 143 pounds for trial 2, also had a higher average backfat thickness, 1.60 inches as compared to 1.32 inches for trial 2; and a smaller loin area 3.55 square inches versus 3.77 square inches for trial 2. These differences explained the occurrence of gross correlations of carcass weight with average backfat thickness, total score and the fat/lean ratio, and the absence in the second analysis of the gross correlations of carcass weight with loin area which had been found in first analysis.



Dressing percentage was related to loin area,  $r_t = .25$ ,  $r_e = .46$ , in the first analysis, and  $r_e = .45$  in the second analysis. The non-significance of the gross correlation of dressing percentage with loin area in the second analysis resulted from the negative correlation of these traits between trials 2 and 3. The positive nature of this particular relationship was puzzling, as previous workers indicated that dressing percentage was very largely dependent upon the amount of fat, although Hammond and Murray (1937) found that liveweight of the pig had the greatest effect on dressing percentage.

In both analyses, dressing percentage and loin area were positively related to carcass weight, hence the positive correlations of dressing percentage to loin area could have arisen from the influence of carcass weight.

The covariance between replicates, in the second analysis, accounted for much of the correlation of dressing percentage with average backfat thickness,  $r_t = .52$ . However, this correlation was in agreement with the correlation of .66 found between dressing percentage and average backfat thickness by Aunan and Winters (1949).

The influence of fatness of carcass on dressing percentage probably accounted for the correlations observed between dressing percentage and total score ( $r_t = -.33$  for trials 2 and 3 and  $r = -.82$  for trial 4).

In the first analysis, R.O.P. carcass length was related to average backfat thickness,  $r_t = .46$ ,  $r = -.49$  and to the fat/lean ratio,  $r_t = -.29$  and  $r_e = -.33$ .



These coefficients of length with backfat were generally larger than those found by Fredeen and Jonsson (1957) and by Harrington and Pomeroy (1954). As was pointed out by Fredeen (1953), some of the negative correlation of length with backfat was automatic when carcass weight was held constant. A given amount of fat would necessarily be thinner, if deposited over a longer carcass.

Average R.O.P. backfat thickness was negatively associated with loin area,  $r_t = -.39$  for the first analysis,  $r_t = -.43$  for the second analysis, and  $r = -.62$  for trial 4. In the first two cases, the gross correlations were not mainly due to covariance between replicates. The above correlations were higher than those reported by Fredeen (1953), who found  $r = -.19$  for loin area to shoulder fat, and  $r = -.21$  for loin area to loin fat; and by Stothart (1938) who found  $r = -.21$  between shoulder fat and length x width of loin.

As in the study of Fredeen (1953), carcass length, average backfat thickness and loin area were highly correlated with total score in this experiment, "as a natural consequence of their contribution to this total." Similarly, average backfat thickness and loin area were highly correlated with the fat/lean ratio, as each was a part of this ratio.

To eliminate the effects on other carcass characteristics of differences in carcass weight between replicates, the gross correlations of carcass weight to these traits were calculated for trial 3, with 34 degrees of freedom. These correlation



coefficients, with the gross correlations from the second analysis (trials 2 and 3) in parentheses, are presented in table 21.

Table 21: SUMMARY OF CORRELATION COEFFICIENTS FOR TRIAL 3

Carcass weight to R.O.P. Backfat	.285	(.410 <del>xx</del> )
Carcass weight to Loin Area	.154	(.026)
Carcass weight to Total Score	-.215	(-.315 <del>xx</del> )
Carcass weight to Fat/Lean Ratio	.053	(.249 <del>x</del> )

Partial correlations, calculated by the formula of Snedecor (1956) are presented for the second analysis, in table 22. The gross correlation of the first two random variables involved in each partial correlation, is given in parentheses. The degrees of freedom are 69.

Table 22: PARTIAL CORRELATION COEFFICIENTS FOR TRIALS 2 AND 3.

r <sub>12.7</sub>	.372 <del>xx</del>	(.516 <del>xx</del> )
r <sub>13.7</sub>	.036	(.044)
r <sub>14.7</sub>	.185	(-.327 <del>xx</del> )
r <sub>15.7</sub>	.228	(.249 <del>x</del> )
r <sub>46.7</sub>	.334 <del>x</del>	(.214)

1 = dressing percentage, 2 = average backfat thickness,  
3 = loin area, 4 = total score, 5 = fat/lean ratio, 6 = length,  
7 = carcass weight.

The correlation coefficients, with the effect of carcass weight removed, indicated an association between dressing percentage and average backfat thickness, and between total score and length, two relationships that had been found to exist in other studies. The relationship between length and total score,  $r = .334$ , was lower than the coefficient of .45 found by Fredeen (1953).



D. The Effectiveness of Certain Predictors of Feedlot Performance and Carcass Characteristics

The correlations of the fat/lean ratio with feedlot performance and carcass characteristics were calculated to determine the utility of the fat/lean ratio as a predictor of other traits. These correlations were, in many cases, similar in size to the correlations of total R.O.P. score with other traits. An exception was the correlation of total score with length which, as would be expected was higher than the correlation of the fat/lean ratio with length. On the basis of the present investigation, no particular advantage, other than ease of calculation, could be attributed to the fat/lean ratio.

The correlations of the average "Lean-meter" probe with other traits was somewhat lower in the first analysis than were the correlations of R.O.P. backfat thickness with other traits. The "Lean-meter" probe was a reasonable predictor of R.O.P. backfat thickness ( $r = .44$  to  $.79$ ) and a slightly better predictor of average backfat thickness measured at the four sites of the probes ( $r = .53$  to  $.84$ ). Tables 14, 17 and 19 summarize the results of the correlation of individual probes with their corresponding carcass measurements. Gross correlations ranged from  $.71$  for shoulder to shoulder in the second analysis, down to  $.25$  for back to back in the first analysis.

The average of four carcass backfat measurements showed no superiority to average R.O.P. backfat as a predictor of other carcass characteristics, although it might well be a better



indicator of carcass fatness.

In table 17 are presented the correlations of apparent dry matter digestibility and apparent crude protein digestibility with other characteristics. Morrison (1956) observed that digestibility of nutrients was affected by the level of nutrition. It was apparent from the analyses of covariance that much of the gross correlations in this experiment was due to the covariance between replicates. Hence the correlations involving apparent digestibilities were recalculated for trial 2 and trial 3 separately, and are presented in Table 23. The degrees of freedom are 34.

Table 23. Relationships of Digestion Coefficients.

<u>Variates</u>	<u>Trial 2</u>	<u>Trial 3</u>
Dry matter digest.-cr. protein digest.	.505 <del>MM</del>	.646 <del>MM</del>
Dry matter digest.-total period ave. daily gain	-.077	-.150
Dry matter digest.-total period ave. daily feed	-.025	-.010
Dry matter digest.-total period feed per lb. gain	.094	.136
Dry matter digest.-Ave. backfat	.333 <del>M</del>	.172
Dry matter digest.-loin area	.334 <del>M</del>	.095
Dry matter digest.-total score	.014	.059
Crude protein digest.-total period ave. daily gain	.114	-.183
Crude protein digest.-total period ave. daily feed	.014	-.142
Crude protein digest.-total period feed/lb. gain	-.079	.037
Crude protein digest.-ave. backfat thickness	.251	.075
Crude protein digest.-loin area	.128	.050
Crude protein digest.-total score	-.060	.055

In the second analysis, the correlations of apparent dry matter digestibility with average backfat thickness were:  $r_t = .03$ ,  $r_e = .14$  and for apparent crude protein digestibility with average



backfat thickness were:  $r_t = -.31$  ~~at~~,  $r_e = .27$ . These figures are not included in table 17.

The liveweight length measurement was found to be correlated with the R.O.P. carcass length,  $r_t = .47$ ,  $r_e = .37$  in the first analysis and  $r_t = .55$ ,  $r_e = .51$  in the second analysis. These correlations do not indicate that the liveweight length, as measured in this experiment, was a very sensitive indicator of carcass length. However, they do suggest that a liveweight measurement of greater accuracy could be useful in predicting carcass length.



Table 12:

SUMMARY OF CORRELATION COEFFICIENTS FOR TRIALS 1 AND 2.  
RELATIONSHIPS AMONG SELECTED FEEDIOT TRAITS.

	Age to Market	40-100 lb.		Total Period	
		Ave. Daily Gain	Ave. Daily Gain	Ave. Daily Gain	Feed /lb. Gain
Age on Test	.718 <del>AA</del> .724 <del>AA</del>	.209 .054		-.250 <del>A</del> -.228	.022 .029
40 - 100 lb. Feed/lb. Gain		-.970 <del>AA</del> -.940 <del>AA</del>			.792 <del>AA</del> .651 <del>AA</del>
Total Period					
Ave. Daily Gain	-.800 <del>AA</del> -.752 <del>AA</del>	.890 <del>AA</del> .742 <del>AA</del>			-.964 <del>AA</del> -.946 <del>AA</del>
Ave. Daily Feed			.362 <del>AA</del> -.061		-.129 .357 <del>A</del>
Dressing Per Cent	.372 <del>AA</del> .257				.357 <del>AA</del> .354 <del>A</del>
R.O.P.					
Carcass Length	-.203 .002		.302 <del>AA</del> .158		-.519 <del>AA</del> -.062
Ave. Back Fat	.250 <del>A</del> .276		-.420 <del>AA</del> -.209		.405 <del>AA</del> .155
Loin Area	-.086 -.178		.218 .204		-.230 -.172
Total Score	-.265 <del>A</del> .003	.413 <del>AA</del> .286	.421 <del>AA</del> .159		-.420 <del>AA</del> -.114
Fat/Lean Ratio	.208 .140		-.394 <del>AA</del> -.268		.398 <del>AA</del> .215
Ave. "Lean- Meter" Probe			-.138 -.072		.121 .015



Table 13: SUMMARY OF CORRELATION COEFFICIENTS FOR TRIALS 1 AND 2.  
RELATIONSHIPS AMONG SELECTED CARCASS TRAITS.

	Carcass Wt.	Dress- ing %	R.O.P. Length	Ave. R.O.P. Fat	Loin Area	Ave. "Lean- Meter" Probe
Final Weight	.736 <del>XX</del> .764 <del>XX</del>	-.163 -.311				-.007 -.022
Dressing Per cent	.548 <del>XX</del> .432 <del>XX</del>					.070 -.005
R.O.P.						
Carcass Length	.064 .225	-.122 -.019				
Ave. Back Fat	-.027 -.070	.166 .070	-.463 <del>XX</del> -.486 <del>XX</del>			.483 <del>XX</del> .463 <del>XX</del>
Loin Area	.340 <del>XX</del> .492 <del>XX</del>	.252 <del>X</del> .456 <del>XX</del>	-.014 -.025	-.338 <del>XX</del> -.146		-.244 <del>XX</del> .035
Total Score	.088 .218	-.066 .014	.601 <del>XX</del> .593 <del>XX</del>	-.823 <del>XX</del> -.762 <del>XX</del>	.535 <del>XX</del> .422 <del>XX</del>	-.503 <del>XX</del> -.421 <del>XX</del>
Fat/Lean Ratio	.025 .347 <del>X</del>	.112 .239	-.292 <del>X</del> -.332 <del>X</del>	.816 <del>XX</del> .796 <del>XX</del>	-.807 <del>XX</del> -.697 <del>XX</del>	.453 <del>XX</del> .304
Ave. Carcass Back Fat	-.022 .045		-.448 <del>XX</del> -.415 <del>XX</del>	.821 <del>XX</del> .820 <del>XX</del>	-.323 <del>XX</del> -.141	.590 <del>XX</del> .544 <del>XX</del>



Table 14: SUMMARY OF CORRELATION COEFFICIENTS FOR TRIALS 1 AND 2.  
RELATIONSHIPS OF SELECTED TRAITS WITH BACKFAT PROBES.

	"Lean-Meter Probes			Live	Initial
	Shldr.	Back	Loin	Wt. Length	Wt.
Carcass	.591 <del>xx</del>				
Shoulder Fat	.550 <del>xx</del>				
Back Fat		.254 <del>x</del> .355 <del>x</del>			
Loin Fat			.529 <del>xx</del> .539 <del>xx</del>		
Ham Fat			.409 <del>xx</del> .401 <del>xx</del>		
R.O.P. Length				.468 <del>xx</del> .374 <del>x</del>	.067 -.169
40 - 100 lbs. Ave. Daily Gain					.208 -.355 <del>x</del>
Ave. Daily Feed					.377 <del>xx</del> .396 <del>x</del>
Feed Per Pound Gain					-.177 .344 <del>x</del>



Table 15: SUMMARY OF CORRELATION COEFFICIENTS FOR TRIALS 2 AND 3.  
RELATIONSHIPS AMONG SELECTED FEEDLOT TRAITS.

	Age to Market	40 - 100 lb.		Total Period	
		Ave. Daily Gain	Ave. Daily Feed	Ave. Daily Gain	Feed /lb. Gain
Age on Test	.574 <del>★★</del> .719 <del>★★</del>	.069 .061		-.045 -.195	.099 .309
40 - 100 lb. Feed/lb. Gain		-.216 -.760 <del>★★</del>	.422 <del>★★</del> .646 <del>★★</del>		.654 <del>★★</del> .529 <del>★★</del>
Total Period					
Ave. Daily Gain	-.756 <del>★★</del> -.707 <del>★★</del>	.859 <del>★★</del> .504 <del>★★</del>			-.346 <del>★★</del> -.796 <del>★★</del>
Ave. Daily Feed			.965 <del>★★</del> .664 <del>★★</del>	.764 <del>★★</del> .137	.333 <del>★★</del> .471 <del>★★</del>
Dressing Per cent	-.232 <del>★</del> .184				.478 <del>★★</del> .411 <del>★</del>
R.O.P.					
Carcass Length	-.074 -.106			.185 .079	-.134 -.171
Ave. Back Fat	-.420 <del>★★</del> -.080			.425 <del>★★</del> -.140	.674 <del>★★</del> -.063
Loin Area	.241 <del>★</del> .175			-.278 <del>★</del> -.190	-.407 <del>★★</del> -.191
Total Score	.429 <del>★★</del> .186	-.315 <del>★★</del> .345 <del>★</del>		-.440 <del>★★</del> -.043	-.693 <del>★★</del> -.339 <del>★</del>
Fat/Lean Ratio	-.041 -.147			.432 <del>★★</del> .000	.664 <del>★★</del> .058
Ave. "Lean- Meter" Probe				.484 <del>★★</del> .276	.696 <del>★★</del> .177
					.299 <del>★</del> -.144



Table 16: SUMMARY OF CORRELATION COEFFICIENTS FOR TRIALS 2 AND 3.  
RELATIONSHIPS AMONG SELECTED CARCASS TRAITS.

	Carcass Wt.	Dress- ing %	R.O.P. Length	Ave. R.O.P. Fat	Loin Area	Ave. "Lean- Meter" Probe
Final Weight	.721 <del>XX</del> .781 <del>XX</del>	-.134 -.186				.163 .298
Dressing Per cent	.590 <del>XX</del> .471 <del>XX</del>					.450 <del>XX</del> -.118
R.O.P.						
Carcass Length	.285 <del>X</del> .324 <del>X</del>	.198 .232				
Ave. Back Fat	.410 <del>XX</del> -.028	.516 <del>XX</del> .148	-.095 -.176			.792 <del>XX</del> .435 <del>XX</del>
Loin Area	.026 .352 <del>X</del>	.044 .452 <del>XX</del>	.011 .105	-.438 <del>XX</del> -.246		-.412 <del>XX</del> -.260
Total Score	-.315 <del>XX</del> .120	-.327 <del>XX</del> .186	.214 .376 <del>X</del>	-.847 <del>XX</del> -.671 <del>XX</del>	.691 <del>XX</del> .637 <del>XX</del>	-.759 <del>XX</del> -.519 <del>XX</del>
Fat/Lean Ratio	.249 <del>X</del> -.249	.325 <del>XX</del> -.190	-.071 -.189	.844 <del>XX</del> .787 <del>XX</del>	-.796 <del>XX</del> -.781 <del>XX</del>	.728 <del>XX</del> .411 <del>X</del>
Ave. Carcass Back Fat	.370 <del>XX</del> .003		-.149 -.226	.869 <del>XX</del> .648 <del>XX</del>	-.503 <del>XX</del> -.262	.842 <del>XX</del> .534 <del>XX</del>



Table 17: SUMMARY OF CORRELATION COEFFICIENTS TRIALS FOR 2 AND 3.  
RELATIONSHIPS OF SELECTED TRAITS WITH BACKFAT PROBES.

		"Lean-Meter" Probes			Live Wt. Length	Dry Matter Digest.	Crude Protein Digest
		Shldr.	Back	Loin			
Carcass:	Shldr.	.711					
	Fat	.374					
	Back		.660				
	Fat		.403				
	Loin			.670			
	Fat			.600			
	Ham				.653		
	Fat				.264		
R.O.P. Length					.550		
					.510		
Crude Protein Digestibility						.607	
						.642	
Total Period Ave.						-.245	-.473
	Daily Gain					-.317	-.047
Ave. Daily Feed						-.221	-.589
						-.057	-.141
Feed Per Pound Gain						.047	-.020
						.280	-.013
Loin Area						.279	.252
						.176	-.047
Total R.O.P. Score						.157	.358
						-.034	-.200



Table 18: SUMMARY OF CORRELATION COEFFICIENTS FOR TRIAL 4.  
RELATIONSHIP AMONG SELECTED CARCASS TRAITS.

	Age to Mrkt.	Total Period A.D.G.	Fat/ Lean Ratio	Carcass Wt.	Dress %	R.O.P. Length	Ave. R.O.P. Fat
Final Weight				.817 <del>AA</del>	-.097		
Age on Test	.363						
Total Frd. A.D.G.	-.941 <del>AA</del>			.264			
Fat/Lean Ratio	-.349	.439		.418			
Dress. Percentage	-.435		-.007	.495			
R.O.P. Length	.129	.010	-.341	.213	-.199		
Ave. R.O.P. Backfat	-.341	.514 <del>A</del>	.874 <del>AA</del>	.452	-.032	-.302	
Loin Area	.334	-.328	-.912 <del>AA</del>	-.234	.010	.251	-.620 <del>A</del>
R.O.P. Score	.381	-.483	-.960 <del>AA</del>	-.473	-.826 <del>AA</del>	.407	-.892 <del>AA</del>
Live Wt. Length						.408	
Ave. "Lean-meter" Probe		.164	.618 <del>A</del>		.139		.460
Ave. Carcass Fat				.512 <del>A</del>		-.491	.789 <del>AA</del>



Table 19: SUMMARY OF CORRELATION COEFFICIENTS FOR TRIAL 4.  
RELATIONSHIPS OF SELECTED TRAITS WITH BACKWAT PROBES.

	Total R.O.P. Score	"Lean-Meter" Probes			Ave. "Lean- Meter" Probe	Ave. Carcass Fat
		Shldr.	Back	Loin		
Final Weight					.208	
Loin Area	.842 <del>AA</del>					-.642 <del>AA</del>
Carcass:						
Shoulder Fat		.475				
Back Fat			.732 <del>AA</del>			
Loin Fat				.459		
Ham Fat					.219	
Ave. "Lean-Meter" Probe	-.648 <del>AA</del>					.717 <del>AA</del>



### GENERAL SUMMARY AND CONCLUSIONS

Differences in feedlot performance and carcass characteristics of swine in these experiments appeared to be caused by differences in the amount of energy available for growth after maintenance requirements had been met, and differences in the type of tissue produced in growth.

The analysis of variance revealed that pigs gained faster, required less feed per pound of gain and had fatter carcasses in the summer feeding period than in winter, probably because of lower maintenance requirements in the summer. A comparison of restricted and liberal feeding regimes revealed that growth was less rapid, efficiency of feed utilization was improved, and carcasses were leaner under restricted feeding. The improved efficiency of feed utilization was probably due to the production of proportionately more lean tissue under restricted feeding than under liberal feeding.

Under liberal feeding it was found that those pigs consuming more feed had higher average daily gains, because they had an excess of nutrients over maintenance requirements. The positive correlations between average daily feed and average backfat thickness, between average daily feed and feed per pound gain, and between feed per pound gain and average backfat thickness suggested that most of the excess nutrients were stored as fat tissue. The efficiency of feed utilization resulting from a greater proportion of nutrients being used for growth was more than offset by the fact that fewer pounds of growth were produced from the excess nutrients, since fat



tissue had a greater energy content than lean tissue.

Under restricted feeding, females gained faster, on less feed, and had leaner carcasses than males suggesting that females had lower maintenance requirements and/or produced relatively more lean than fat tissue as compared to males. Under liberal feeding, males had higher average daily gains, greater feed requirements per pound of gain and fatter carcasses than females, likely because of their greater feed consumption and consequent availability of more nutrients for growth.

The causes of the differences in growth, efficiency and carcass characteristics between sires were inseparable, but certain relationships suggested one explanation to be more probable than others. For instance, the pigs from Landrace sire 340N, under both feeding regimes, had some of the larger loin areas and thinner backfat measurements, while their feed consumption was relatively low, suggesting that their higher average daily gains and lower feed requirements were due to their production of relatively more lean tissue. On the other hand, pigs sired by Landrace 50M, under both feeding regimes, had some of the smaller loin areas and thicker backfat measurements, indicating that their lower average daily gains and higher feed requirements under restricted feeding, and higher average daily gains and feed requirements under liberal feeding, were due to their production of a higher proportion of fat to lean tissue than was the case for the pigs sired by 340N. Their average daily consumption of feed on trial 3 was the greatest of all sire groups, giving them a greater excess of nutrients for growth, which they apparently stored as fat tissue. In



this instance there seems to be some tendency for pigs to eat to supply an inherent energy requirement.

The use of the "Lean-meter" to determine backfat thickness was fairly successful, indicating that this instrument could be a useful tool in swine improvement. A body length measurement was indicative of the carcass length, however, further refinements of the technique of obtaining the body length would be required for this measurement to be used in predicting carcass length.

The fat/lean ratio, involving backfat thickness and loin area, showed no superiority over total R.O.F. score nor average backfat thickness as an indicator of other carcass traits.

Apparent digestible dry matter and apparent digestible crude protein differed only between the levels of daily feed intake. However, it was not determined whether the retention of nutrients by the body was significantly different, as the excretion of metabolic products could have been higher under liberal feeding, indicating the lower apparent digestibilities.

Under a system of restricted feeding, those pigs having the highest average daily gains were more efficient in their use of feed, had thinner backfat and tended to have larger loin areas. Hence, selection pressure for high average daily gain under a system of restricted feeding would be expected to increase efficiency of feed utilization, to lower average backfat thickness and to at least maintain, if not increase, loin area. Under systems of non-restricted feeding, the fastest gaining pigs were the least efficient, tended to have thicker backfat and had the smallest loin areas. Selection pressure for high average daily gain under these systems would be expected to cause a decrease in



efficiency of feed utilization and loin area, while backfat thickness would tend to increase. The rate of change of these traits with a change in average daily gain would, of course, depend upon their genetic correlation to average daily gain.

It would appear from the results of this experiment that testing of swine under a system of restricted feeding has merit in that the desirable feedlot performance traits and carcass characteristics would be found in the same individuals. The comparison of sire groups under restricted and liberal feeding showed that the best group under restricted feed was also one of the better groups under liberal feeding, while one group that gained poorly under restricted feeding reversed their position under liberal feeding by expressing their ability to consume a greater amount of feed, although this was at the expense of efficiency and carcass leanness. The ultimate choice between the two systems of testing swine would depend upon the importance of differences in voluntary feed consumption in swine performance.



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